# Color Values in Monochrome



A LECTURE ON

# Orthochromatic Photography

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*With the Compliments of the Author.*

# Color Values in Monochrome by Photography

It is a matter of common experience among all photographers, that the print from a negative taken on an ordinary plate does not represent, even approximately, colors in their true values. Everyone has noticed, for instance, that in general, in photographs, blue, a comparatively dark color, is represented by a tone several shades lighter than that produced by the much brighter color, yellow. We have grown so accustomed to this defect of photography that a photographic print which correctly represents the color values of the object, looks strange and, at first glance, untrue. It is, however, not a matter of common knowledge that this defect of photography can be overcome, and that colors can be represented in their true values, or, what is a better term, luminosities in a monochromatic print.

## Light and Color

In the first place, it is necessary to investigate the nature of color and the nature of the effects produced by it, or rather by what causes it, on the photographic plate. It seems hardly necessary to state that color, as a purely physical process,

does not exist, but that it is a physiological effect peculiar to the eye; that, without the eye, there would be neither light nor color, but merely an exceedingly rapid and, at the same time very minute vibration or quivering of that hypothetical medium, filling all space, which is called the ether. It is this vibration, acting on the retina, that is the primary cause of the sense of sight; while the various colors that we see are produced by differences in the magnitudes and, at the same time, in the frequency of these vibrations; the ether waves that produce the red and orange colors being longer than those that give rise to violet and blue. Roughly speaking the sensation of red is caused by waves in the ether about $\frac{1}{37000}$ inch long, green by waves $\frac{1}{50000}$ inch long, and violet by waves $\frac{1}{60000}$ inch long. Similarly the effects on a photographic plate are due, not to any particular color or colors, but to ether vibrations of certain definite wave lengths, some of these producing, when acting on the retina the sensation of color, while others, which strongly affect the plate, have no action on the eye. If throughout this paper, therefore, certain colors are spoken of as acting on the plate, it is to be understood as referring to the particular ether vibrations that excite those color sensations.

## Color Constants

There are three constants generally used in defining color: Purity, Hue and Luminosity.

**Purity** The purity of a color refers to its freedom from admixture with any other color and is always judged with reference to the spectrum, whose colors, when it is properly formed, are absolutely pure. A spectrum, approximately pure, can be formed by projecting, by means of the lantern, an image of a narrow slit in a piece of metal in the slide carrier on the screen, and interposing in the path of the rays a prism or prisms. The narrow band of white light is broken up or decomposed by the

**The Spectrum** prisms into a broad, brilliantly-colored band whose appearance is familiar to all. The general arrangement and spacing of the colors can be seen by reference to the upper, left-hand corner of Fig. 1, pages 24-25, which is a diagram of the particular spectrum used. The lines drawn across the diagram and lettered are the principal absorption lines of the solar spectrum, and answer the purpose of indicating, when their positions are known, the wave length and color of the light at any part of the spectrum. The lengths of the ether waves decrease as you go from the line A to the line H or from red to violet, and any particular color can be exactly defined by giving the length of the wave producing it. Purity of color, then, is due to light of, approximately, a single wave length, represented of course by a very narrow band in the spectrum, and not to the superposition of waves of different lengths which would produce an

**Natural Colors** impure color. All natural colors are, generally speaking, more or less impure, and are produced by the mixture of pure colors; but all colors appear pure to the eye which has not the power of estimating, unaided, the purity of a color, or of resolving impure or mixed colors into their constituents. A color which, to the eye, appears pure, and as nearly as possible equal to the spectrum color, may be composed of nearly all the spectrum colors. This can be shown by interposing colored glasses in the path of the beam of light pro-

**Absorption Spectra** ducing the spectrum. The effect is to cut out or absorb, partially or wholly, some of the colors, allowing the others to be fully transmitted, and this is illustrated in black and white by the diagrams in Fig. 2. The rectangular figures are intended to represent the spectrum of white light, while the shaded portion represents the part transmitted by the particular glass considered. and the unshaded part what is absorbed. The resultant color of the glass by transmitted light is evidently that produced by the union of the spectral colors transmitted.

**Hue** The hue of a color is the name given to what is commonly known as color, without reference to other attributes. Ordinarily when we speak of a particular color, we mean the hue of that color and do not refer to either the purity or the

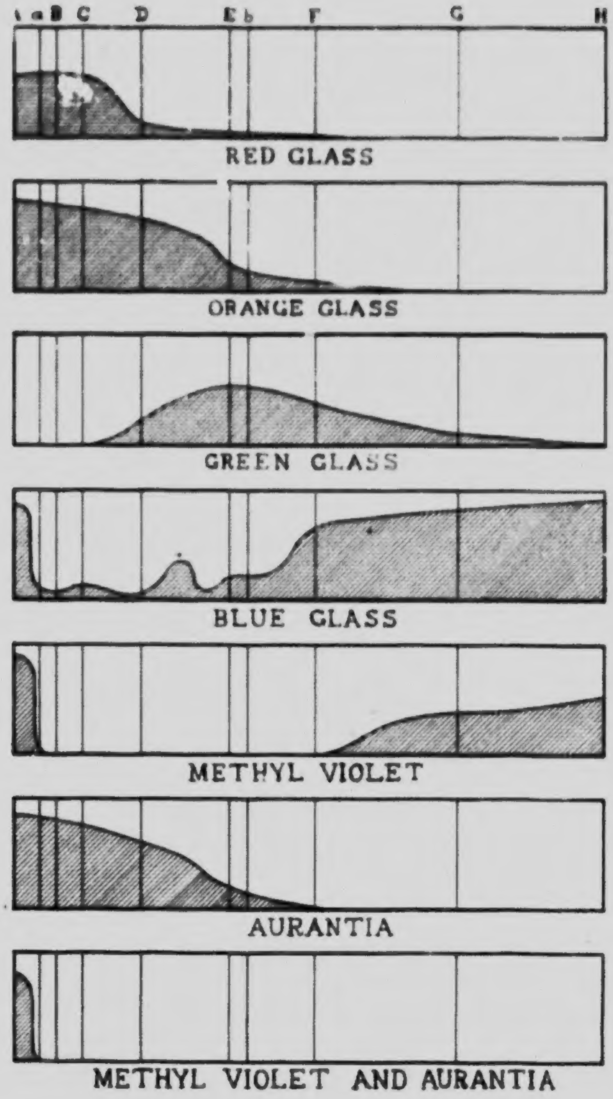



Fig. 2.

luminosity. Thus the hue of blue glass is blue, although, on analysis, it is found to contain not only blue but all the other colors of the spectrum, in a greater or less degree, blue and violet predominating. It is the combination of these pure colors in a certain

proportion that produces the blue hue which is, of course, not pure.

**Luminosity** The luminosity of a color is the relative brightness of that color with reference to any standard, and is evidently the only attribute of color that can be rendered in black and white. Photography, being a process in monochrome, can not render contrasts of color or hue, but only contrasts of luminosity or light and shade. That is to say if there are two hues, red and blue, for instance, of the same luminosity, a photograph or any reproduction in monochrome should represent them as of exactly the same shade of grey. The truth of this statement will perhaps be more evident to you, if you ask yourself which should be the darker. Ordinarily, however, a photograph will not represent them as of the same tint, and our object is to see if we can not obtain, in a photograph, an exact representation of the luminosities of the object or objects depicted, irrespective of their colors. Evidently, then, it is necessary, in order to make accurate comparisons, to measure the relative luminosities of colors.

**Luminosity of the Spectrum** It is at once seen on observing the spectrum, that certain of the colors, such as orange and yellow, are much brighter or more luminous than any of the others. The actual brightness, or luminosity, or light intensity of the

various colors of the pure prismatic spectrum has been accurately determined by many investigators, Frauenhofer, Crova and Lagarde, Abney and others. Captain, or as he now is, Sir William Abney's values were taken and plotted out as ordinates or vertical lengths above the spectrum diagram of Fig. 1, pages 24-25, before referred to. Thus, for each particular wave length or corresponding color, the value of the luminosity was taken, and a length proportioned to that value was set out in the vertical line through its position on the spectrum diagram. The resultant curve, drawn through these points, shows graphically the luminosity at any part or of any color of the spectrum. It is at once seen, from the figure, that greenish yellow is the brightest color, the values shading down rapidly on either side to the red and blue.

## Luminosity of Pigment Colors

It can not, of course, be inferred from this that, in natural or pigment colors, greenish yellow is always the brightest; in fact it may be so shaded with black as to be less luminous than a red or blue. In order to obtain the luminosities of colors, other than the pure spectrum colors, which are in actual practice seldom used, it is necessary to measure them. There are several methods of doing this, perhaps the simplest being to compare the luminosity of the color to be measured, with the luminosity of the grey produced by the

mixture of black and white. A disc of black and a disc of white card of the same diameter, which were slit along a radius to allow overlapping, were placed on the same axis as a disc, of greater diameter, of the color to be measured and rapidly rotated. The eye determines, almost instinctively, whether the color is brighter or darker than the grey produced. When it is judged that they are equally bright the luminosity of the grey, and hence of the color, is determined from the relative proportions of black and white producing the required grey. If the rotation apparatus has a device for changing the proportions of black and white during rotation, the measurement is much more easily and accurately made. By this method, and with the assistance of Mr. A. H. Abbott, B.A., of the Psychological Laboratory of the University, who has had considerable experience in photometry, the luminosities of a set of colors, for which I am also indebted to Mr. Abbott, were determined. These colors, pasted on black cardboard, were used as a test object, and a photograph of this test chart is reproduced in Fig. 3. It will at once be seen, from the card being represented white, that the figure is a negative of the chart. In that case, if the plate correctly rendered luminosities, the brighter the color the darker should be its representation. In fact the densities of the strips should be proportional to the lengths of the radial lines which repre-

**Color Chart**

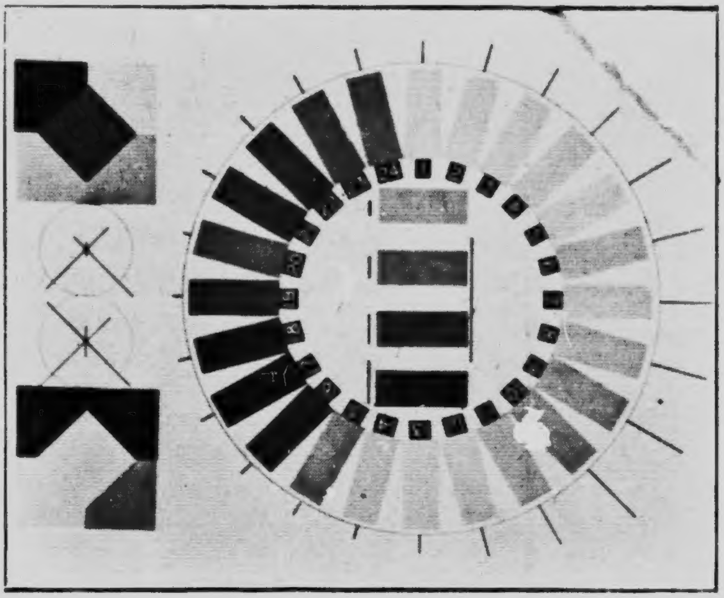


Fig. 3.—Color Chart on Cramer "C" Plate.

sent, graphically, the measured luminosities of the colors. The negative, of which Fig. 3 is a reproduction, was made on an "ordinary" (Cramer "C") plate, and it shows, at a glance, the correctness or rather the incorrectness of the representation. The brightest colors, Nos. 9 and 10 (yellow and yellowish green), instead of being represented by the heaviest deposit, have only slightly affected the plate, while some of the darker colors, notably the blue (No. 17), have the greatest action on the plate as represented by the densest deposit.

## Photographs of the Spectrum

The explanation of this curious result is easily seen, when you examine a photograph of the spectrum on such a plate. Fig. 4 is a reproduction of the negative and has superposed, in addition, the spectrum chart and luminosity curve previously referred to. The positions of the colors and of the absorption lines are shown by the latter, and it can at once be

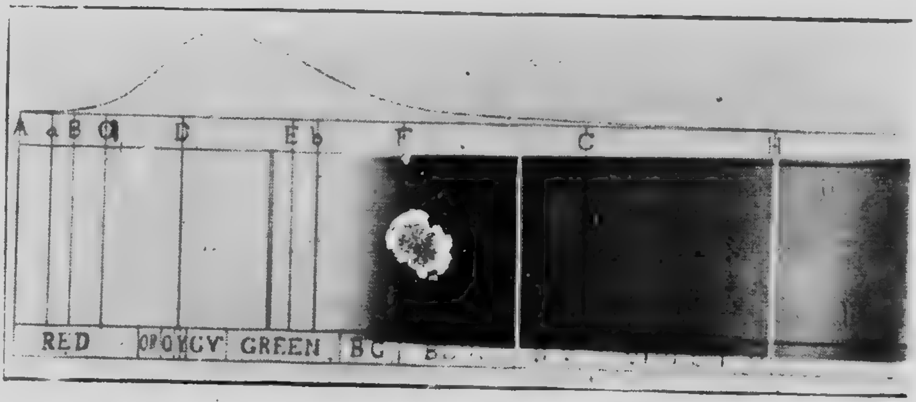



**Fig 4.– Photograph Spectrum on Cramer "C" Quartz Prism.**

seen which of the spectrum colors are impressed on the plate. It is found that the waves giving rise to the red, orange, yellow, and yellow-green colors have no effect on the plate; while waves giving rise to the blue and violet sensations, and other waves called the ultra violet, beyond the limit of the visible spectrum, produce very marked deposits on the plate. This peculiar behaviour of the plate under the spectrum at once affords an

explanation for the defective rendering of color values in the photograph of the color chart, and will also explain the peculiarities of color rendering so common in ordinary photographs.

**Color Sensitive Plates**

The evident remedy for such a state of affairs is to produce a plate which is sensitive to all the visible spectrum colors, and, moreover, which is most sensitive to those which are most luminous, and in direct proportion to their luminosity. For if we can photograph the spectrum correctly, we can also photograph any other object correctly, whose colors are always composed of spectral or mixtures of spectral colors. And, in fact, we can reproduce natural colors more satisfactorily than spectrum colors, for the reason that, although the dominant hue of the object may be one that, if pure, would not affect the plate, still other colors composing this dominant hue may be active and help to produce a truer rendering than if the colors were pure.

**The Ideal Plate**

A plate, sensitive to wave lengths corresponding to all the spectral colors in proportion to their luminosity, and insensitive to wave lengths longer or shorter than these, has not yet been discovered, nor, if an opinion may be expressed, will it ever be discovered. We have plates now, however, which are a decided improvement over the ordinary type,

and which, by the aid of a certain artifice, will produce exceedingly close approximations to the ideal result.

**Historical Sketch**

The originator of this later type of plate was, undoubtedly, the late Prof. H. W. Vogel, of Berlin, who, in 1873, observed that collodio-bromide plates, stained with a yellow dye, were much more sensitive to the yellow band of the spectrum than unstained plates, and who, after further investigation, announced that if certain red or yellow dyes were used to stain these dry collodion plates, their sensitiveness to yellow and green was much increased. This discovery created quite a sensation in the photographic world, and the action of a large number of the coal tar dyes was investigated by scientists such as Eder, Abney, Bothamley, Ives and others. The introduction of the gelatino-bromide dry plate, and its marvellous qualities absorbed photographers' attention for some time, and orthochromatism (from two Greek words meaning "correct color"), as it was called, was allowed to lapse, and was apparently forgotten.

**Commercial Processes**

But in 1882-'83 Tailfer and Clayton at Paris patented a method for making the gelatino-bromide dry plate color-sensitive by adding eosin to the emulsion before coating. This method, improved as regards the keeping qualities of the plates, was introduced

into England by B. J. Edwards & Co. in 1884.

**American** In America, John Carbutt inaugurated the commercial manufacture of color-sensitive plates in 1886, while later the Cramer Co. purchased the Edward's process and so improved it that, according to their claim, the use of color screens was largely avoided. They called their productions isochromatic (equal color) plates, and these plates, which give very good results, can be obtained in Toronto. Many of the American dry plate manufacturers have now added orthochromatic plates to the list of their products.

**French** In France Lumière Bros. have introduced a remarkable series of plates sensitised for varying portions of the spectrum. Series A, sensitive to yellow and green; series B, sensitive to yellow and red; and series C or panchromatic sensitive to red, yellow, and green. In this connection it must be noticed that all orthochromatic plates, as well as ordinary plates, are decidedly too sensitive to blue and violet.

**English** In England among several commercial brands of orthochromatic plates, besides Edward's, already referred to, I will only mention two, the Ilford chromatic and the Cadett spectrum, as these can be obtained in Toronto. The Ilford chromatic is a very clear working and brilliant plate, with which excellent results can be obtained; its principal disadvantage is its slowness, which

practically debars its use, especially with screen, wherever there is movement.

**The Cadett Spectrum Plate is remarkable in two ways: for its extreme rapidity, being by far the fastest orthochromatic plate made, and for its sensitiveness to all the spectrum colors, with the exception of a narrow band in the extreme red. Messrs. Cadett and Neall have issued light filters for use with the Spectrum plate, which enable a true record of color luminosities, with the exception of the dark red before mentioned to be obtained.**

## The Theory

It can not be, as yet, definitely explained why the silver salts in the film are rendered sensitive to light vibrations of longer wave length, by the addition of certain dyes. Two theories have been propounded to account for it. According to the physical theory, the light vibrations absorbed by the dyes are transferred to the silver salts, thus rendering them sensitive in the region of absorption. In support of this theory is the fact that each dye sensitises in that portion of the spectrum which it absorbs. The chemical theory states that the coloring matter is decomposed under the action of light, the complex molecule of the dye giving rise to products, which act as reducing agents on the silver salts. In support of this theory, in like man-

ner, is the fact that the best sensitisers are those dyes most unstable under the action of ligh t.

**Methods of Sensitising** There are, as will have been noticed from the historical sketch, two methods of orthochromatising, or, more simply, sensitising plates. The first method is by immersing an ordinary plate in a bath of the dye solution, eosin, erythrosin, and cyanin, being the dyes most commonly employed. The second method is to incorporate the dye with the emulsion in the process of manufacture. Practically the same effects can be obtained, but, aside from the troublesome nature of the first process, plates prepared by bathing have not good keeping qualities, from one to four weeks being the limit ; while plates prepared by the second method keep nearly as well as ordinary plates. In preparing plates by the bath method only a very weak solution of the dye is needed, one part in from 3,000 to 25,000 parts of water ; and, to increase the sensitiveness of the plates, although reducing their keeping qualities, a little ammonia may be added. The plates are immersed for one or two minutes, as a rule, and are then dried in the dark.

**Bathed Plates** I prepared some Cramer "C" plates by immersion, sensitising them with eosin, with erythrosin, and with cyanin, and these plates were then used to photograph the spectrum.

If it is desired to obtain exact quantitive results from a test of this nature it is necessary to form a pure spectrum on the plate by means of a spectroscope. This could not be arranged without special apparatus, so a spectrum, formed as previously described, was used and a photograph of this taken in a camera. The results obtained by this method, although not giving an exact measure of the amount of light action of the various parts of the spectrum, clearly indicate the effects produced on the different plates, and, when placed in the form of diagrams, enable comparisons to be made.

**Spectrum Photographs**

From the negatives thus obtained curves were drawn, in the same manner as the luminosity curve before referred to, except that the length of the vertical lines was taken as proportional to the light action on the plate, or, what is the same thing, to the density of the resulting negative. The resultant curve and the luminosity curve were then drawn above a figure showing the positions of the absorption lines, and evidently, the more nearly these curves coincide, the better will be the color renderings of the plate. In the upper, right-hand corner of Fig. 1 is the diagram representing the effect on a Cramer "C" plate, the negative itself being reproduced in Fig. 4, and at the other side of the figure is another diagram from the same brand. The former was taken

**Graphical Method**

from a spectrum produced by a quartz prism, which transmits the ultra violet waves, while glass prisms, used in the latter, and in all the others, absorb them. It will be observed, from the diagrams of the bathed plates, that the general effect is to render them sensitive to the longer waves without appreciably diminishing their sensitiveness to the shorter or blue and violet waves.

### Commercial Ortho-chromatic Plates

The other diagrams shown in Fig. 1 were drawn, as will be seen from the titles in the figure, from negatives of the spectrum on three different

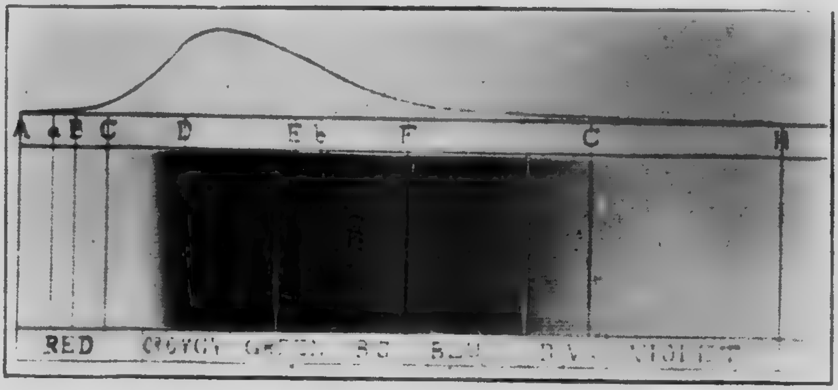



Fig 5.—Photograph of Spectrum on Cramer Iso. Med.

brands of commercial orthochromatic plates, the Cramer Isochromatic of medium speed, the Ilford Chromatic, and the Cadett Lightning Spectrum. These are, so far as I know, the only makes obtainable in Toronto. To avoid choosing any particular brand for experiment, the three were investigated, as impartially as possible, and the results will be

presented with no more comment than seems necessary for explanation. Fig. 5 is a reproduction of a negative of the spectrum on a Cramer Isochromatic medium plate, and it can at once be seen how much better an effect is produced than on a Cramer ordinary plate. The greatest density now is obtained between the D and E lines, in the greenish-yellow, nearly at the point of greatest luminosity. The diagrams in Fig. 1, pages 24-25, show quite a similarity, especially between the Ilford and Cramer, the Cadett, however, being more sensitive to the orange and red waves.

**Sensitiveness to Blue**

These curves show that, although the addition of a dye or dyes to the emulsion, before or after coating, has the effect of rendering the plates sensitive to vibrations causing sensations of green, yellow, and in some cases, red, there is still too great sensitiveness, by far, to the vibrations giving rise to blue and violet sensations, to correctly render color luminosities. There are two

**Methods of Correcting**

methods of overcoming this difficulty: first, by diminishing the sensitiveness of the plates to the blue and violet waves, second, by diminishing the action of the blue and violet waves on the plate. A correction, or even an approach to a correction, by the first method has not yet been attained, nor does it appear likely to be attained. The second method, however, offers a simple means, by

absorbing part of the blue and violet waves, of overcoming the difficulty. It will be remembered that the effect of interposing colored glass in the path of the beam producing the spectrum was to absorb, partially or wholly, some of the spectrum colors. If then a colored glass or film can be obtained, which will absorb most of the blue and violet and all the ultra violet waves, and if this be placed in the path of the beam of light entering the camera, near the lens being the most convenient place, the luminosity renderings should be materially benefited.

## Color Screens

A device of this nature is called a color screen or ray filter, and its appearance by transmitted light is, in general, yellow or orange. The absorption diagram of orange glass in Fig. 2 represents, in a general way, the absorption caused by color screens. Screens may be composed of colored glass, stained gelatine or collodion film, or a liquid solution contained in a thin glass cell with parallel sides. They may be placed in front of, or behind the lens of the camera, or directly in front of the plate; or the same object would be attained by illuminating the subject with yellow or orange light. The dyes commonly employed for staining the films are some of the coal tar series, the principal ones being aurantia, aniline yellow, naphthol yellow, brilliant yellow and others, while chromate and bichromate of potassium in solution are generally used for liquid screens.

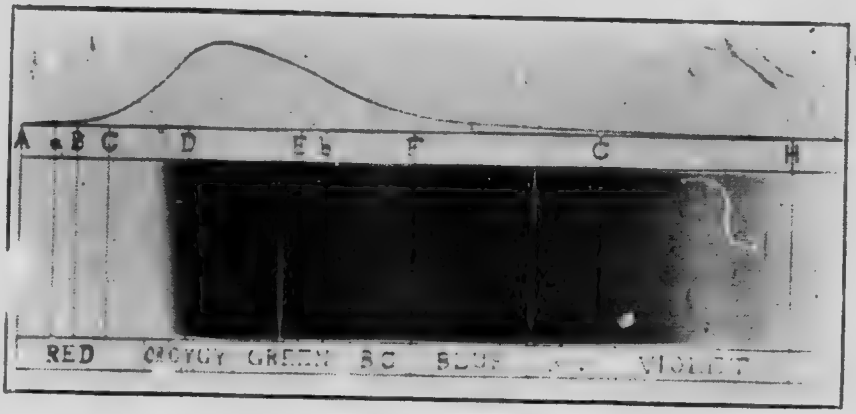



Fig. 6.—Photograph of Spectrum on Ilford Chromatic and Screen.

**Effect of Color Screens** The effect produced by employing such screens when photographing the spectrum is shown in Figs. 6 and 7, which are reproductions of the negatives obtained. Fig. 6 is a negative on an Ilford chromatic plate using a liquid screen of a yellow color, while Fig. 7 is a negative on a Cadett spectrum plate using the Cadett Absolutus screen, which is of a reddish orange color. Again Fig. 1 pages 24-25, represents, diagrammatically, these results, with two others, and shows

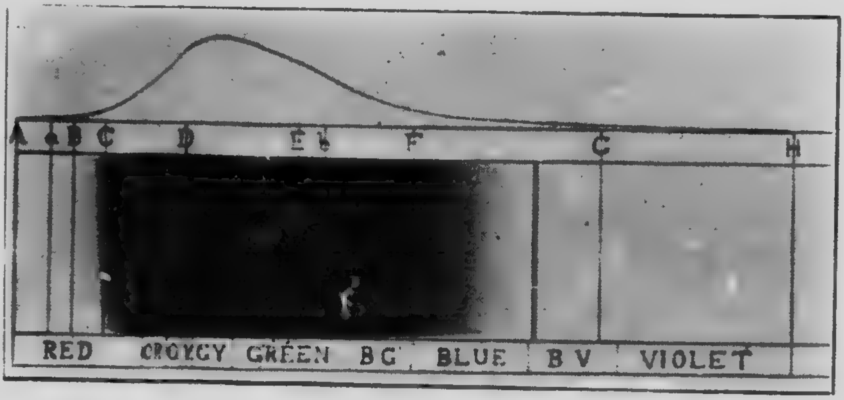



Fig. 7.—Photograph of Spectrum on Cadett Spectrum and Absolutus Screen.

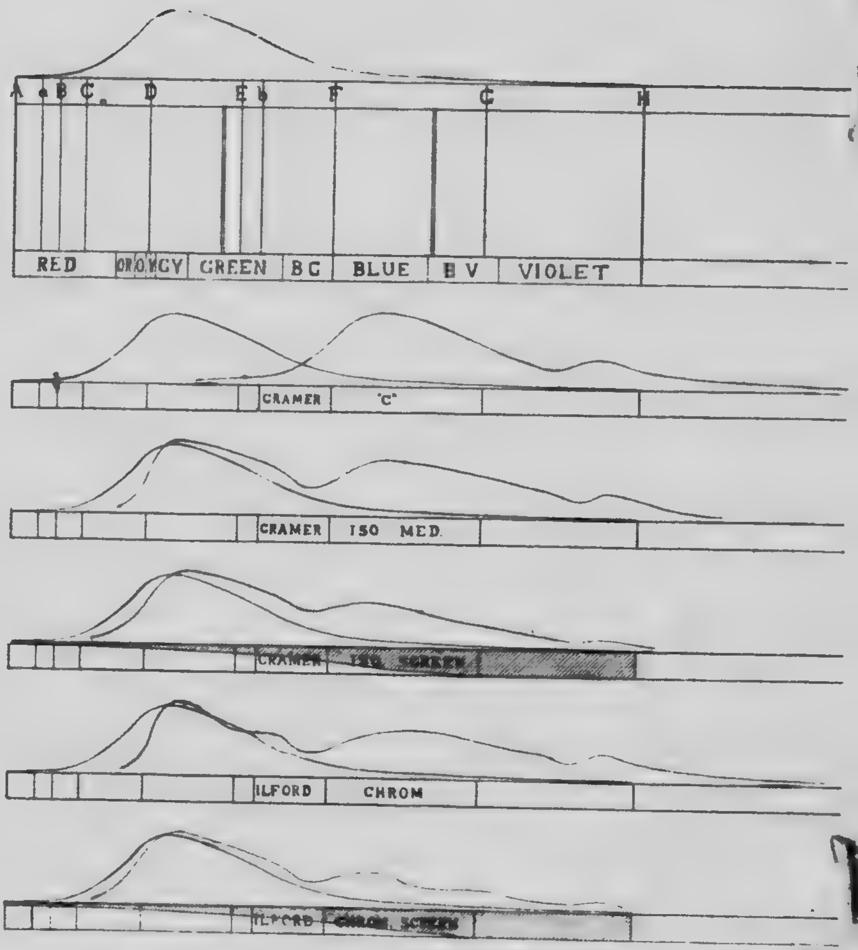
the decided advantage of using screens. The two curves are brought nearer to coincidence, especially when using the Absolutus screen, and the effects obtained thus approach very closely the ideal result.

### Color of Screens

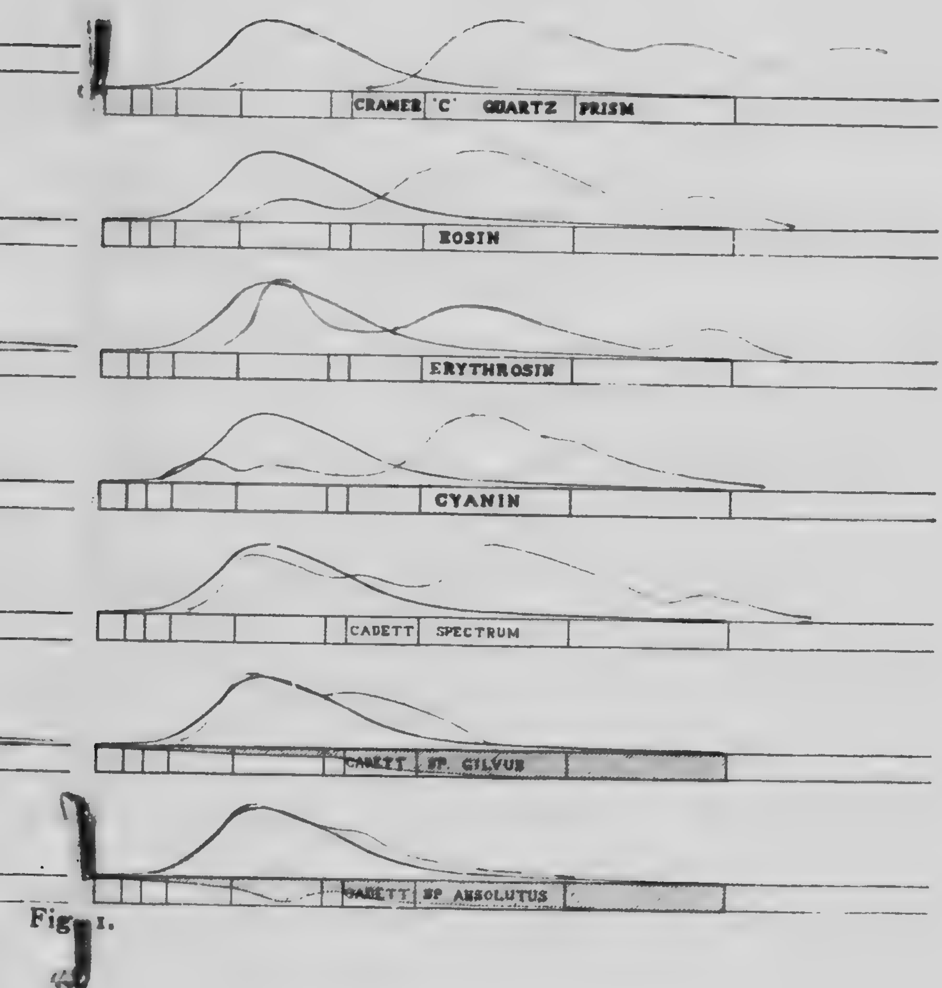
Evidently, the yellower or more orange the screen the more blue is cut out, and it is easily possible to get a screen so deep in color as to render the blues too dark in the print, while, if not deep enough, they will be too light. It will be noticed, also, in the diagrams of the unscreened plates, that each brand has a different shape of curve, and one screen will not, therefore, suit all plates. To obtain the best results, the screen should be so adjusted to the plate as to absorb waves having too vigorous an action, and to transmit freely those with too feeble an action.

### The Cadett Screens

Up to the present Cadett and Neall are the *ONLY* makers of orthochromatic plates who have attempted to supply screens correctly adjusted. They have issued two screens for use with the Spectrum plate, the Gilvus and the Absolutus. The Gilvus increases the exposure about five times, and the Absolutus about forty times. This increase of exposure is due to the absorption of the most chemically active waves, and applies, of course, in a greater or less degree to all color screens. It is claimed that the Gilvus screen gives correct rendering of all color luminosities but


A a B C D E b F G H
RED
GREEN
B G
BLUE
B V
VIOLET
CRAMER 'C'
CRAMER ISO MED.
CRAMER
ILFORD CHROM

Fig


CRAMER 'C' QUARTZ PRISM
EOSIN
ERYTHROSIN
CYANIN
CADETT SPECTRUM
CADETT SP. GILVUS
CADETT SP. ABSOLUTUS
Fig. 1.

the red, and the Absolutus gives correct values to all colors but a narrow band in the extreme red. The Ilford Co. also supply two screens of colored glass, a light and a dark, increasing exposure about three and six times respectively. The screens of course, are not adjustable, and no claim is made as to color renderings. The Cadett screens are, I believe, made of four stained films, two gelatine and two collodion sealed in optical contact between two pieces of optically worked glass, and hence allow considerable variations in the absorptions produced.

**Absorption Spectra of Screens**

These absorptions, and that of the liquid screen used, are indicated, in a rough way, by the shaded part of the rectangle below the diagrams in Fig. 1. On comparing this with the curve above, and with the curve for the same plate without a screen a very good idea of the function of the screen may be obtained.

**Method of Adjustment**

The same curves will also serve to indicate the method to be pursued in adjusting screens to plates. Take a photograph of a pure spectrum through the screen to be tested on the plate to be tested, measure the densities of the different parts of your negative, and plot a curve to correspond. It can at once be seen, on comparing this curve with the luminosity curve, what colors have too vigorous an action, and the screen can be

changed to absorb more of that color. It is essentially a method of trial and error, and, owing to the tedious photometric measurement of densities, is not suited for commercial purposes.

**Abney's Color Sensitometer** Captain Abney has devised a simple instrument, which he calls a color sensitometer, for the same purpose. He takes, usually, four pieces of colored glass, red, yellow, green and blue, which transmit approximately pure colored light. The luminosity of the light transmitted by each is accurately measured, and behind the three lightest are introduced rotating sectors, or patches of developed grey of such density as to reduce their luminosity to that of the darkest. Then red, yellow, green and blue light, all of equal luminosity, will be transmitted, which should give, on a plate behind a correctly adjusted filter, patches of equal density. As the glasses need only be very small, the whole apparatus, with the plate to be tested, can easily be placed in a quarter plate printing frame, and hence is quickly and cheaply tested. If the patches are not of equal density, and this can readily be judged by the eye, the filter must be changed to absorb more of the color giving too dense a patch, or less of the color giving too light a patch. This, as before, is a method of trial and error, but with the advantage over the former of avoiding the tedious measurement

of densities, and of overcoming possible errors due to improper exposure or development, while the results obtained with screens so adjusted, should be equally good.

**Results from Spectrum** The results obtained in photographing the spectrum show decidedly the advantages of orthochromatic over ordinary plates, the advantages of screened over unscreened orthochromatic plates, and finally the advantages of scientifically screened orthochromotic plates over all others. In photographing colored objects of all kinds we will see that the same results obtain as in the photographs of the spectrum. This is what is to be expected when it is considered that the colors of all objects are either spectral colors or mixtures of spectral colors.

**Results from Color Chart** As a test object, a color chart was constructed by pasting colored paper on a sheet of black cardboard. Twenty-four different hues, intended to represent spectral colors as closely as possible, were arranged on the circumference of a circle and four different shades of grey inside. At the two lower corners of the card ten other colors were arranged in two squares. As a guide to the colors arranged on the circumference I may say that No. 1 is red, No. 5 orange, No. 9 yellow, No. 13 green, No. 17 blue, No. 21 violet, and the intermediate strips are intermediate in hue. As before mentioned, the

radial lines around the circumference represent, by their lengths, the luminosities of the colors, and, in the same way, the lines arranged between the two colored squares represent the luminosities of the strips composing the squares. It must be distinctly remembered that all the figures of this chart are reproductions of negatives, and hence, in a correct rendering of the color luminosities of the strips, the densities of the patches of grey representing the strips should be exactly proportional to the lengths of the lines beside them.

**Ordinary Plates**

Fig. 3, already mentioned, is a negative on a Cramer "C" plate and imme-

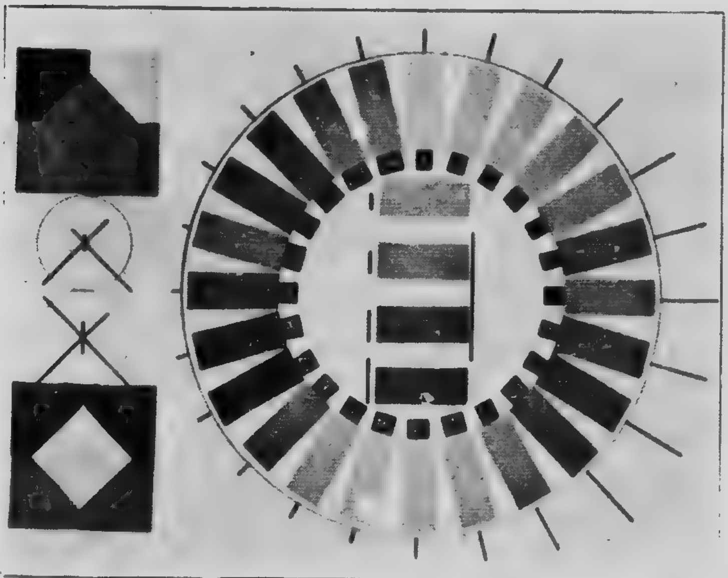


Fig. 8– Photograph Color Chart on Cramer Iso Med.

diately shows the very faulty record given by ordinary plates. Three other brands of ordinary plates were tried, and, although the

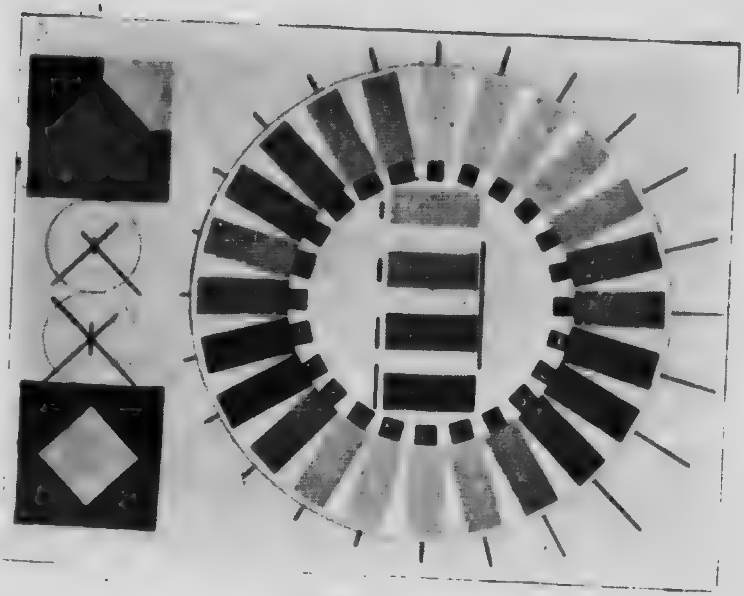


Fig. 9.
Photograph of Color Chart on Ilford Chromatic.

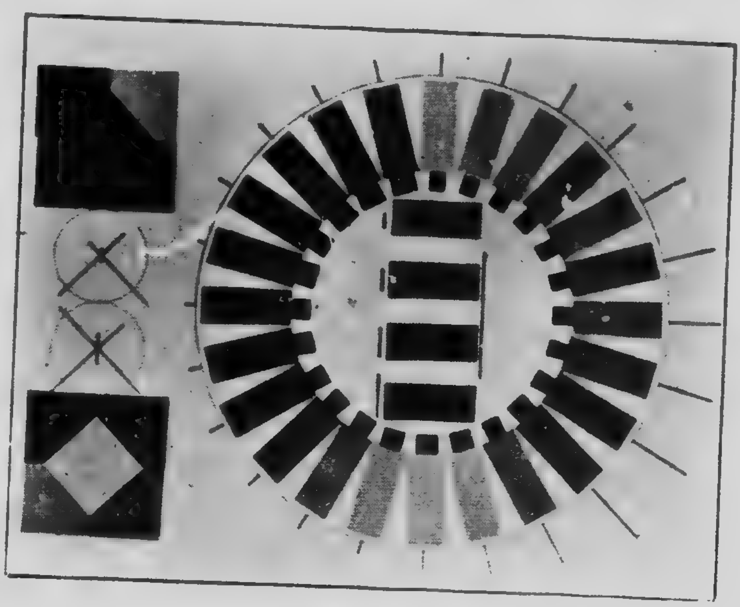


Fig. 10.
Photograph of Color Chart on Cadett Spectrum.

differences were not very marked, the Cramer was undoubtedly the best. Fig. 8 is

**Ortho-chromatic Plates**

from the negative on a Cramer Isc. medium plate, Fig. 9 an Ilford Chromatic and Fig. 10 a Cadett Spectrum. These three, although giving a much better result than ordinary plates, are still far from perfect. The patches representing the blue and violet strips are much too dense, while the yellows

**Advantage of Screens**

are not dense enough. When we use the same remedy as before, a screen to absorb some of the blue and violet, the improvement is decidedly marked and in three of the remaining figures the values of the circular set of strips are as nearly as can be judged by the eye, approximately correct. Figs. 11 and 12 are on Ilford Chromatic plates with the Ilford light screen and a liquid screen of a full yellow color respectively. Figs. 13 and 14 are on Cadett Spectrum plates with the Gilvus and the Absolutus screens respectively. The two lower squares form a severer test of the qualities of plates and screens than the circle, and it is with these that the final comparison must be made.

**Composite Nature of Colors**

It is evident, from the comparison of spectrum and color chart negatives on ordinary plates, that the values given by the latter, although far from correct, are not so faulty as we would be led to expect from the photographs of the spectrum. The cause of

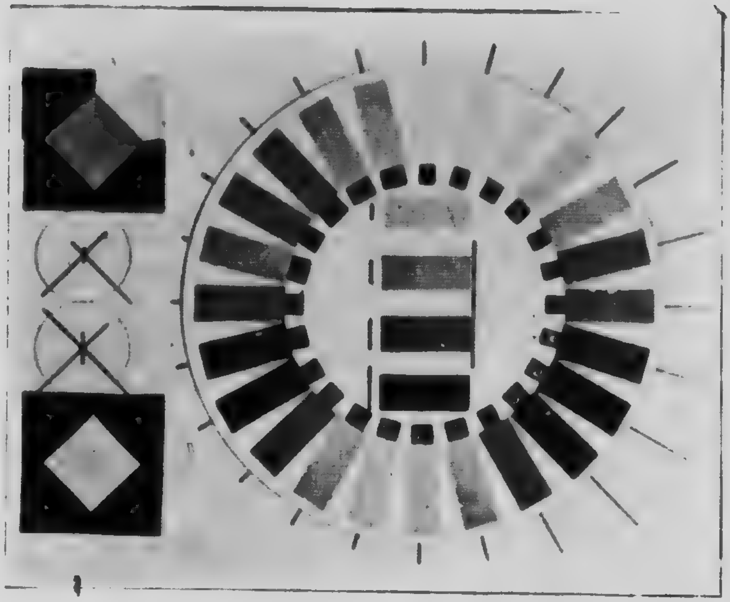


Fig. 11.
Photograph of Color Chart on Ilford and Ilford Screen.

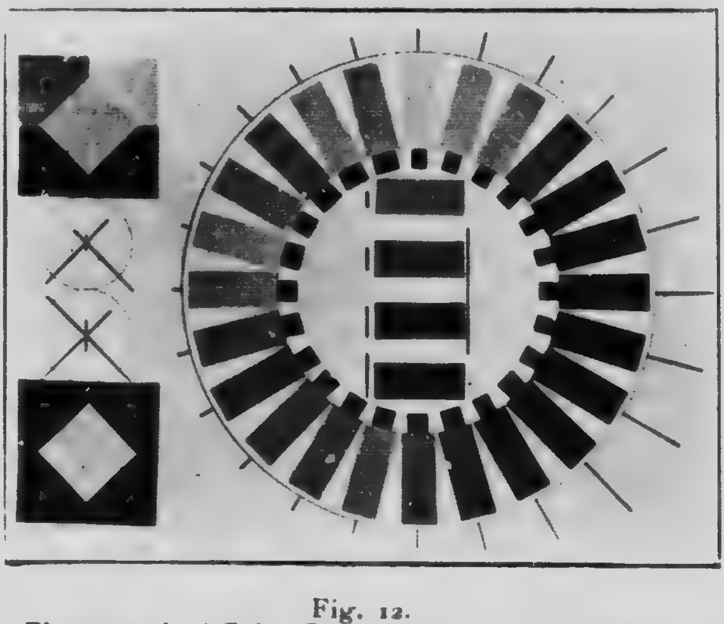


Fig. 12.
Photograph ot Color Chart on Ilford and Bichrome Screen.

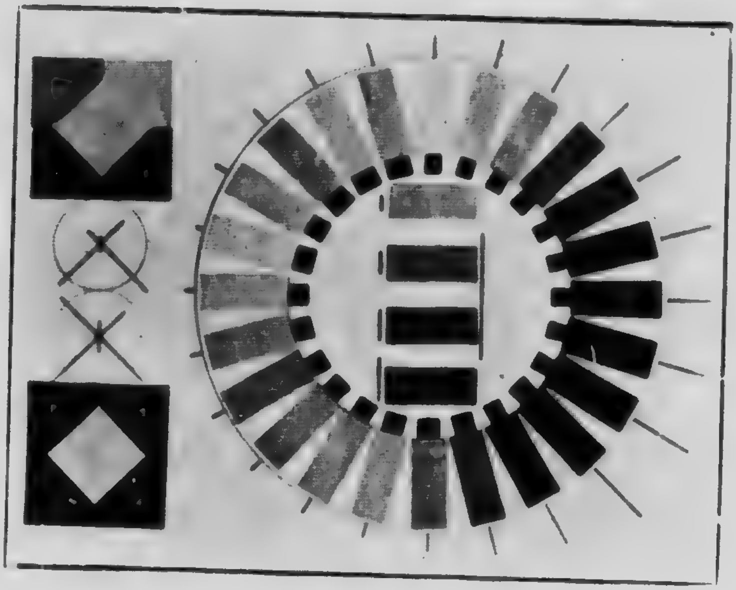


Fig. 13
Photograph of Color Chart on Cadett Spectrum and Gilvus Screen.

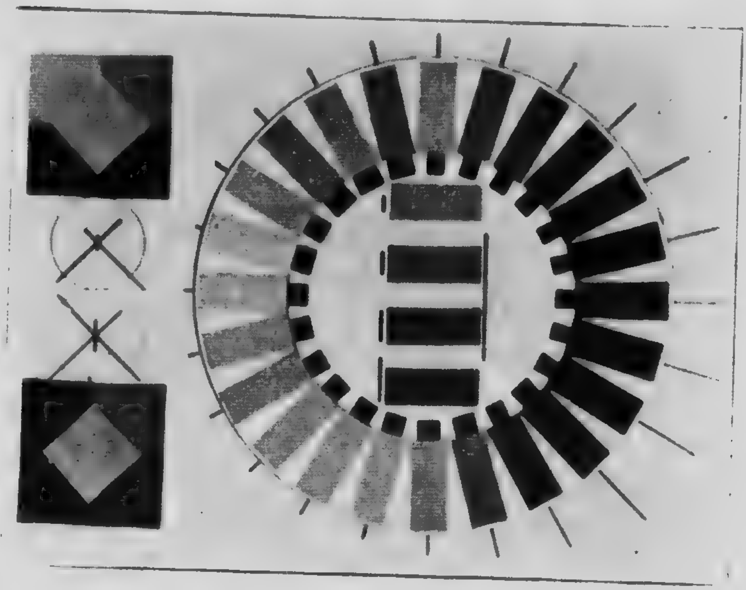


Fig. 14.
Photograph of Color Chart on Cadett Spectrum and Absolutus Screen.

this is evident when the colors are analysed spectroscopically. It will be found that they do not reflect one or two colors only, but, generally speaking, all the colors but one or two, which are, of course, complementary to the dominant hue. The composite nature of these colors, and indeed of all colors in nature, is an aid to their correct rendering. If the colors of natural objects were pure spectral colors, the ordinary plate, being sensitive only to the blue and violet, would not be affected by green, yellow, orange or red, and, as a consequence, they would alike be rendered, in the print, as one mass of black without form or detail.

**Colored Pictures** It is a natural transition from the pigment colors on the test chart to those used in paintings and other colored pictures, and similar effects will be noticed in their reproduction. In all colored pictures, especially old paintings or pictures containing deep brown or other dark tints, the use f a screen, comparatively deep in color, is necessary to obtain the values of the different colors, and indeed it seems to be impossible to obtain detail in the shadows without such a screen. In the subject chosen for reproduction (no figures; slides shown in original lecture) this is shown in a marked degree. The difference between the results obtained on ordinary and on orthochromatic plates without a screen is not very marked, but when screens are used the improvement

is very noticeable. Not only is the effect much more brilliant, and free from the flatness which characterizes the former, but also detail is obtained in the browns and reds which is entirely absent in the unscreened pictures. Moreover it is quite evident from the results that a deep screen (the "Absolutus") gives much better rendering than a plain full yellow, or orange screen, and that, by the use of a properly adjusted screen, effects completely satisfying to the eye can be obtained.

**Flowers** The colors of nature, on the other hand, are chiefly of interest in this connection as they are present in flowers, fruit, etc., and in landscapes. Flower photography is another branch of the art in which orthochromatic plates offer decided advantages over ordinary plates. The use of a screen, however, is not so indispensable for the best results as in the case of pictures. Indeed, if there are no blue or violet flowers, better results will often be obtained without a screen, as its use, especially if at all deep in color, seems to intensify the yellows, causing them to appear too white in the positive or print. An exception must be made to this statement in the case of the Absolutus screen, which, when used with the Spectrum plate, always possesses a decided advantage. A screen is necessary, if there are blue or violet flowers, to cut down their actinic value and to prevent them appearing too light in the print. These points are illustrated in the slides (no figures) of crimson,

pink, and yellow roses, and violets. The orthochromatic plates without a screen give better values than the ordinary plates, but in both the violets are by far too light. The use of a yellow screen, although bringing the violets to their correct tone, makes the yellow roses too light, and the only method of overcoming this difficulty is to use a screen adjusted by one of the methods previously described.

**Landscapes** The last and, to most photographers, the most important branch of photography, landscapes, also exhibits in comparative results the advantages of color sensitive plates. At this time of the year, winter, when landscapes contain little else but black and white, orthochromatic plates, naturally, do not show such marked advantages over ordinary plates as in spring, summer or autumn. They still possess, however, in several points, qualities sufficient to recommend their use. These points are: first, used with or without a screen, better detail in the snow can be secured; second, parts of the landscape uncovered with snow show much more detail on orthochromatic plates, especially with a screen, than on ordinary plates; third, clouds can be obtained without special care in developing or printing, at the same time as the landscape, and here also a screen is an advantage. But it is chiefly in the other seasons that the advantages of orthochroma-

tic plates are most marked, and I am satisfied that no one who makes a fair trial of orthochromatic and ordinary plates on the same subject will be ever again content with the faulty records of the latter. These advantages, which, as well as those of winter scenes, are illustrated by slides, are: improved rendering of the various shades of green in the foliage, the general brightening of the effect on a dull or hazy day, the clearing up of an excess of haze obscuring the distance, and, finally, the possibility of

**Clouds**

obtaining, especially when a suitable screen is used, clouds and landscape in the same negative. Even if there are no clouds, the use of a screen will produce a very natural tone in the sky, gradually lightening as it approaches the horizon, and any clouds, even very light and fleecy ones, will show in the print, as in nature, as white on a darker background.

**Screens**

The foregoing remarks indicate that, in the majority of cases, the use of a screen is necessary if true color values are desired. In the reproduction of pigments in any form a screen is necessary, and it is generally desirable in other subjects, as flowers and landscapes. If these latter subjects contain yellows and greens only, the use of a screen would not cause a marked difference in the result, but if there are blues or violets, then a screen sufficiently deep in color to tone down their actinic value to cor-

respond with their luminosity value is necessary.

**Varieties of Screens** As regards the kind of filter, the most desirable, if it could be obtained of the correct tint, would be a piece of optically worked colored glass. But, as will readily be seen, it is practically impossible to obtain a suitable color. The liquid screens, such as the Bausch & Lomb ray filter, present the advantage that their color can be varied by altering the strength of the solution, but possess the drawback that the liquid evaporates and requires replenishing, and that the inside of the cell gets dirty and requires cleaning, which is troublesome to accomplish. Screens made of stained gelatine or collodion films, either coated on glass or sealed between two glasses, can be obtained of any desired tint and can consequently be correctly adjusted. There is no liquid to be spilled and evaporate, but care has to be taken to keep them from the light when not in use, as there is danger of fading.

**Cadett Screens** In working with the Cadett spectrum plates, it would be advisable to use the screens they supply, as much better results would be obtained than with any screens not specially adjusted. The Gilvus can be used for all, or nearly all landscape work, and does not increase the exposure sufficiently to prohibit instantaneous work. The Absolutus should

be used where absolutely correct values are required, and when the increase of exposure permits. If both can not be obtained, the Gilvus would probably be the most generally useful for amateurs. For use with the Ilford, Cramer and other orthochromatic plates it is useful to possess two screens, a yellow and an orange, the yellow answering for ordinary landscape work, and the orange when there are fleecy clouds to be reproduced, or in photographing pictures. The Ilford screens, light and dark, made of colored glass, would answer for most purposes, and are quite convenient to use. Whatever screen is used, however, it is essential that the glass or glasses of which it is composed be perfectly plane and parallel, or distortion, and consequent loss of definition, will inevitably result.

### Unadjusted Screens

### Manipulation of Orthochromatic Plates

Before concluding a few remarks about the working of orthochromatic plates might be of service to beginners in the method. It has often been urged against their use that they are troublesome to manage in development, and of poor keeping qualities. Orthochromatic plates, certainly, can not be exposed so freely to the regular ruby light as ordinary plates without danger of fog, but ample light can be used, especially in the latter stages of development, to properly watch progress; and while, perhaps, not keeping so well as ordinary plates

their good qualities are preserved much longer than is generally imagined; for instance, a box of Ilford Chromatic plates, which I purchased nearly a year ago, yields excellent negatives without any sign of deterioration.

**Exposure** When using slow orthochromatic plates, such as the Ilford Chromatic and the Cramer Iso. Med., ample exposure is required. For, while they seem to possess great latitude as far as over-exposure is concerned, the evil effects of under-exposure are far more marked than is the case with ordinary plates. In my experience with these two makes not one plate has been over-exposed, although, as I thought, ample exposure was always given. The Cadett Spectrum plate, as is natural with a very fast plate, has not so great latitude, and care must also be taken not to over-expose. As a guide to the exposure required, if we take the typical case of an ordinary landscape on a bright day in summer, at three o'clock in the afternoon, and if the lens be stopped to f-11, the Ilford Chromatic would require an exposure of at least $\frac{1}{10}$ second, the Cramer Iso. Med. $\frac{1}{12}$ second, the Cramer Iso. Inst. $\frac{1}{30}$ second, and the Cadett Spectrum $\frac{1}{50}$ to $\frac{1}{100}$ second, depending on the speed number of the emulsion. If a yellow screen were used these exposures would be increased four or five times, and the slow plates could not be used for instantaneous work, even with an aperture of f-8.

### Dark Room Lights

The developing light that is safe to use in working orthochromatic plates depends, of course, on the plate. Plates that are insensitive to red can be worked in a deep ruby light without fear of fog, but plates sensitive to red can not be safely exposed to such a light. For plates of the former class, of which the Ilford and Cramer are examples, the regular ruby and orange glass may be used, with the illuminant turned down low, and the plates exposed to the direct rays as little as possible during the early stages of development; when development is nearing completion, however, the light may be turned up to examine progress without danger of fogging the plate. For plates of the latter class, of which the Cadett Spectrum is an example, development will either have to be conducted in darkness, or with a light which transmits a color to which the plate is insensitive. Cap-

### Safe Lights

tain Abney recommends two gelatine films, formed from dry plates fixed and washed, one stained deeply with methyl violet, the other with brilliant yellow, and bound together film to film with lantern slide binding strips. The absorption spectra of methyl violet and aurantia, which is similar to brilliant yellow, are shown in Fig. 2, and it will be observed that, while methyl violet transmits a narrow band in the extreme red and some blue and violet, aurantia transmits everything but blue and violet. If the two are combined the

result will be, as shown in the lower diagram, to transmit only the extreme red, and such a combination, if carefully used, should be safe with the Spectrum plates. Sanger Shepherd recommends three films, of methyl violet, naphthol yellow, and aurantia, and for a combination still more safe naphthol yellow, aurantia, brilliant green, and fuchsin. The Cadett safe light, which can be purchased ready to use, will probably prove most suitable for amateur's use, and is, I believe, composed of a film stained with methyl violet and two colored glasses, yellow and yellow green. Even when using these safe lights it would do no harm to keep the tray covered, during development, as much as possible.

**Developers**

The developers to be used for orthochromatic plates do not differ materially from those ordinarily employed. In fact any developer suitable for an ordinary plate can be used on an orthochromatic plate. There is one point to be guarded against, however, when working with slow plates such as the Ilford and Cramer Medium, and that is to use only about one half the usual quantity of the developing agent or reducer, pyro, metol, eikonogen, or whatever is used, with the usual quantity of alkali, and to make up the balance with water. It will be found that if a developer of full strength is used on these plates, the negative will be too dense and contain

**Excess of Contrast**

too much contrast to give harmonious results. This peculiarity, the great density giving powers of orthochromatic plates, should be of great advantage for any subject whose contrasts it is wished to increase, for instance a landscape flatly lighted, or on a cloudy day. For such an effect the proportion of developing agent might be increased with advantage. Very fast plates, such as the Cadett Spectrum, do not require this precaution and in fact the developers for these plates call for a larger proportion of reducer, or rather for a smaller proportion of alkali. The object of this, no doubt, is to prevent chemical fog which is more likely to occur with fast plates, but in my experience I had no difficulty with fog, and the development proceeds in exactly the same manner, only more slowly, as with ordinary plates.

**Necessity for Experience** In fact the manipulation of orthochromatic plates differs only in the points mentioned from that of ordinary plates and no difficulty should be experienced in their successful handling. It must be remembered, however, that any change in materials or methods in photography requires experience to become familiar with the new conditions imposed, and hence that perfect results should not be expected to be attained with the first box of plates.

**Conclusion** In conclusion I can only hope that I have succeeded, as well as the limits of a single lecture allow, in making you familiar with the main points about orthochromatism and the correct rendering of color values. I trust also that what has been said and shown to you will at least tempt you to give the method a fair trial. If once tried, I am fully convinced that you will never again be satisfied with the ordinary plate, and will thus hasten the day when its faulty record will be replaced by the correct rendering of color luminosities given by the orthochromatic plate.

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